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The influence of temperature on the change in the partial density of electronic states in the valence band and the magnetic properties of monocrystalline $RE_3Ni_5Al_{19}$ compounds (RE = Gd, Tb)

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Research on highly correlated systems is a key trend in physics. The $RE_3Ni_5Al_{19}$ series has been the subject of intensive research on the physical properties of actinides (RE = U and Th) and lanthanides (RE = Sm and Yb). It has been shown that $U_3Ni_5Al_{19}$ is a heavy-fermion antiferromagnet with TN = 23 K and exhibits non-Fermi liquid behavior below 5 K under ambient pressure [1]. The unusual and interesting behavior of known $RE_3Ni_5Al_{19}$ compounds has recently inspired research on other RE atoms in this structure, which may lead to the discovery of new materials with unusual properties. Further research may contribute to a better understanding of the magnetic properties and their complexity in this series of compounds.

We present temperature-dependent spectroscopic studies of the electronic structure and magnetic behavior of monocrystalline intermetallic compounds $RE_3Ni_5Al_{19}$ synthesized via the Al self-flux method. These compounds exhibit complex magnetic behavior with multiple phase transitions (three for both $Gd_3Ni_5Al_{19}$ and $Tb_3Ni_5Al_{19}$), suggesting strong interplay between electronic structure and magnetism [2]. Using high-resolution X-ray photoelectron spectroscopy (XPS) and resonant photoemission spectroscopy (ResPES) at photon energies corresponding to the M-edges of RE and the L-edge of Ni, we investigate the temperature-induced changes in the partial density of electronic states in the valence band. Measurements are performed both at room temperature and in the low-temperature regime, above and below the observed phase transition points (25 K and 21 K for $Gd_3Ni_5Al_{19}$; 32 K, 29 K, and 20 K for $Tb_3Ni_5Al_{19}$). The goal is to distinguish the individual electronic contributions of Ni and rare-earth atoms to the valence band near the Fermi level, and to correlate these with the magnetic ordering processes occurring at different temperatures.

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References

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